

Ollscoil na hÉireann, Gaillimh
National University of Ireland, Galway

Summer Examinations, 2004/2005

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| Exam Code(s) | 1BA1;1BS1;1CS1;1EL1;1ER1;1MR1;1PT1 |
| Exam(s) | First Science and First Arts |
| Module Code(s) | MP102 |
| Module(s) | Mathematical Physics |
| Paper No | 1 |
| Repeat Paper | |
| External Examiner(s) | Prof. Brian Straughan |
| Internal Examiner(s) | Dr. Mícheál Ó Confhaoila |
| | Dr. Pat O'Leary |
| | Dr. Michael Tuite |
| Instructions: | Attempt all questions. You may assume that the gravitational constant $g = 10 \text{ ms}^{-2}$ throughout. |
| Duration | 2hrs |
| No. of Answer books | |
| Requirements | |
| Handout | |
| MCQ | |
| Statistical Tables | Yes - Log Tables |
| Graph paper | |
| Log Graph Paper | |
| Other Material | |
| No. of Pages | 1 |
| Department(s) | Mathematical Physics |

1. A car accelerates with constant acceleration of 2 ms^{-2} from an initial velocity of 2 ms^{-1} over 8 m. Find the final velocity and the time taken
2. A particle moves along a line with position $s = t - t^2$. Draw the velocity/time diagram for $0 \leq t \leq 1$.
3. A particle moves with acceleration $\mathbf{a} = t\mathbf{i} - 3\mathbf{j} + 4\mathbf{k}$ at time t . If the initial position and velocity are given by $\mathbf{r}_0 = 2\mathbf{i} + 3\mathbf{j}$ and $\mathbf{u} = \mathbf{i} + 4\mathbf{k}$ respectively, find the position vector for all time.
4. Consider the vectors $\mathbf{a} = 2\mathbf{i} + 4\mathbf{j} - \mathbf{k}$ and $\mathbf{b} = \mathbf{i} + 2\mathbf{j} + 3\mathbf{k}$. Find the angle between them.
5. A block is projected with velocity 5 m/s along a rough horizontal plane with coefficient of friction $\mu = 0.25$. How far does it travel before being brought to rest?
6. A ball is projected with velocity 6 m/s under gravity. Find the maximum possible horizontal range.
7. A particle of mass 3 kg is at the end of a horizontal elastic spring of natural length 2 m and modulus of elasticity 2 N. Find the potential energy stored if the spring is extended by 0.5 m, from its equilibrium position.
8. A mass m attached to an inextensible cable of length a (which is fixed at the other end) moves in a circle with velocity v . Find the tension in the cable.
9. A mass attached to a spring experiences a displacement $x = \cos(t) - 2\sin(t)$. What is the amplitude of the simple harmonic motion?
10. A uniform cube with sides of length a lies on an inclined plane. Assuming no slipping occurs, find the angle at which the cube topples.
11. Find the moment about the origin of the force $\mathbf{F} = 3\mathbf{i} - \mathbf{j} + \mathbf{k}$ acting at the point $(1, -2, 1)$.
12. A system of forces consists of three forces $\mathbf{F}_1 = \mathbf{i} - \mathbf{j}$, $\mathbf{F}_2 = 3\mathbf{j}$ and $\mathbf{F}_3 = -2\mathbf{i} + \mathbf{j}$ acting at $\mathbf{r}_1 = \mathbf{0}$, $\mathbf{r}_2 = -\mathbf{i}$ and $\mathbf{r}_3 = \mathbf{j}$ respectively. Find an equivalent system of forces consisting of a single force \mathbf{F} acting at $\mathbf{r} = \mathbf{0}$ together with a couple \mathbf{M} .
13. Solve the first order linear differential equation where $x(0) = 2$

$$\frac{dx}{dt} + 2x = 3.$$
14. A 3 Kg ball with initial velocity of 4 m/s collides elastically with a second ball of mass 1 Kg at rest. Find the final velocities assuming the motion is along a line.
15. A two dimensional plate is made by joining the edge of a square plate of side a to the edge also of a side a of a rectangular plate of sides a and $2a$. Assuming that both plates are of the same constant density, find the centre of mass of the solid.
16. Find the moment of inertia of a uniform circular ring of radius a about an axis through the edge and perpendicular to the plane of the ring.